

1c644 U.S. PTO  
09/30/99

Patent Application  
Docket No. 99-CN-118

A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of: Albert Vareljian

For: TELEPHONE LINE INTERFACE CIRCUIT AND METHOD

JC549 U.S. PTO  
09/408742  
09/30/99

BOX APPLICATION  
Assistant Commissioner  
for Patents  
Washington, D.C. 20231

CERTIFICATE OF MAILING BY EXPRESS MAIL

"EXPRESS MAIL" Mailing Label No. EL058675165US

Date of Deposit: September 30, 1999

I hereby certify that this paper or fee is being deposited with the U.S. Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

Type or Print Name DEBORAH A. KELLY

Deborah A. Kelly

Signature

Sir:

PATENT APPLICATION TRANSMITTAL LETTER

Transmitted herewith for filing, please find the following:

- X Specification, claims and abstract of the above-referenced patent application (total of 29 pages)
- X Three sheet(s) of drawing(s) (   formal/  
  X   informal).
- X Combined Declaration and Power of Attorney.
- An Assignment of the invention to:
- A verified statement claiming small entity status under 37 CFR 1.9 and 1.27.
- Other (specify):

The filing fee has been calculated as shown below:

	NO. FILED	NO. EXTRA	RATE	FEE
<b>BASIC FEE</b>				<b>\$ 760</b>
<b>TOTAL CLAIMS</b>	<b>31 -20</b>	<b>11</b>	<b>\$18</b>	<b>\$ 198</b>
<b>INDEPENDENT CLAIMS</b>	<b>3 - 3</b>		<b>\$78</b>	<b>\$</b>
<b>MULTIPLE DEPENDENT CLAIM(S) PRESENTED</b>			<b>\$260</b>	<b>\$ ____</b>
<b>TOTAL FEES:</b>				<b>\$958.00</b>
<b>Deduct one-half of fee for Small Entity</b>				
<b>TOTAL AMOUNT DUE:</b>				<b>\$958.00</b>

— Please charge my Deposit Account No. 10-0447 in the amount of \$\_\_\_\_\_

X A check in the amount of \$ 958.00 is attached. Please charge any deficiency or credit any overpayment to Deposit Account No. 10-0447.

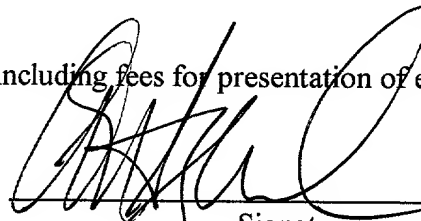
— The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No. 10-0447.

— Any patent application processing fees under 37 CFR 1.17 and under 37 CFR 1.20(d).

— The issue fee set in 37 CFR 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

— Any filing fees under 37 CFR 1.16 including fees for presentation of extra claims.

Date: 9/30/99

  
Signature  
Andre M. Szuwalski  
(Name of Attorney of Record)  
Registration No. 35,701

JENKENS & GILCHRIST  
3200 Fountain Place  
1445 Ross Avenue  
Dallas, Texas 75202-2799  
214/855-4795

Patent Application  
Docket No. 99-CN-118

CERTIFICATE OF MAILING BY EXPRESS MAIL	
"EXPRESS MAIL" Mailing Label No. EL058675165US	
Date of Deposit:	September 30, 1999
I hereby certify that this paper or fee is being deposited with the U.S. Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231.	
Name:	Deborah A. Kelly
Signature:	Deborah A. Kelly

TELEPHONE LINE INTERFACE CIRCUIT AND METHOD

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to an interface circuit for a telecommunications line, and particularly to a hybrid circuit  
5 for communicating over a telephone line.

Background of the Invention

Hybrid circuits have been used in modems or other communication devices to isolate the modem receiver from being  
10 affected by transmissions of the modem transmitter. Known hybrid circuits include a transformer circuit utilizing at least two transformers. Although somewhat effective in isolating the

modem receiver path from the modem transmitter path, the transformer hybrid circuit is expensive to implement on an integrated circuit.

5 A second known hybrid circuit is a resistive divider circuit implemented in a resistor bridge configuration. The resistive divider circuit, however, degrades the signal strength of the signal transmitted over the telecommunications line and itself generates an appreciable amount of thermal noise due to the presence of resistors therein, thereby providing a  
10 relatively poor signal-to-noise ratio. Consequently, for handling communication over a relative high loss line, such as a twisted pair telephone line, a resistive divider hybrid circuit is not a perfect solution.

Other attempts to separate the receive path of a modem from  
15 the transmit path thereof include the use of a filter. In order to provide a substantially complete isolation of the received signals from the transmitted signals, however, a very high order filter having a relatively high dynamic range is required. As is well known, such filters are quite expensive to implement.

20 Based upon the foregoing, there exists a need for a hybrid circuit for a modem or other device which effectively and economically isolates the receive path from the transmit path.

## SUMMARY OF THE INVENTION

The present invention overcomes the shortcomings in prior systems and thereby satisfies a significant need for a hybrid circuit for a modem or other device having a transmitter and a receiver associated with a telecommunications line, such as a telephone line on which information is communicated in two directions using the ADSL protocol. The hybrid circuit substantially cancels signals generated by the modem transmitter from appearing at the input of the modem receiver and filters signals, such as echo signals, at unwanted frequencies so that the receiver primarily receives at its input signals transmitted from a remote device.

In particular, the hybrid circuit includes a capacitive divider which suitably scales the signals generated by the transmitter and the signals appearing on the telecommunications line so that common portions of the two scaled signals substantially cancel each other at the receiver input. In addition, the capacitive divider is configured as a filter so that signal components at unwanted frequencies are substantially filtered from appearing at the receiver input. In the event the hybrid circuit receives downlink information from a remote device along the telecommunications line using the ADSL

protocol, the capacitive divider is configured as a high pass filter.

5 In a preferred embodiment of the present invention, the hybrid circuit is associated with a differential pair of telecommunication lines over which information is communicated. The transmitter includes a differential output and the receiver includes a differential input. In this scenario, the hybrid circuit includes a pair of capacitive dividers, each of which is configured as a filter. In the event the hybrid circuit receives downlink information from a remote device over the 10 telecommunications line using an ADSL protocol, each filter circuit is configured as a high pass filter. Alternatively, in the event the hybrid circuit receives uplink information from a remote device over the telecommunications line using an ADSL protocol, each filter circuit is configured as a low pass 15 filter.

In a second preferred embodiment of the present invention, the hybrid circuit is associated with a single ended telecommunications line. Accordingly, the transmitter output and the receiver input are each single ended. The hybrid 20 circuit in this embodiment includes a single capacitive divider configured as a filter. In use in receiving downlink information from a remote device over the telecommunications

line using ADSL, the capacitive divider forms a high pass filter. Conversely, in receiving uplink information from a remote device over an ADSL telecommunications line, the capacitive divider forms a low pass filter. The hybrid circuit  
5 is connected between the transmitter output, receiver input and the telecommunications line. An inverting amplifier is connected between the transmitter output and one terminal of the capacitive divider so as to generate a signal that, after being suitably scaled by the capacitive divider, cancels like signal  
10 components appearing on the telecommunications line.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the system and method of the present invention may be obtained by reference to the following Detailed Description when taken in conjunction with  
15 the accompanying Drawings wherein:

Figure 1 is a function block diagram of a hybrid circuit according to the present invention in association with a transmitter and receiver;

20 Figure 2 is a schematic diagram of a hybrid circuit according to a first embodiment of the present invention;

Figure 3 is a schematic diagram of a hybrid circuit according to a second embodiment of the present invention;

Figure 4 is a schematic diagram of a hybrid circuit according to a third embodiment of the present invention; and

Figure 5 is a schematic diagram of a hybrid circuit according to a fourth embodiment of the present invention.

5

**DETAILED DESCRIPTION OF THE PREFERRED EXEMPLARY EMBODIMENTS**

Referring to Figures 1 and 2, there is shown a hybrid circuit 1 according to a preferred embodiment of the present invention. Hybrid circuit 1 is coupled to one end of a telecommunications line 2 over which information is communicated. Hybrid circuit 1 cooperates with transmitter 3 and receiver 4, each of which is coupled to telecommunications line 2. Transmitter 3 and receiver 4 respectively transmit and receive information over telecommunications line 2.

It is understood that hybrid circuit 1, transmitter 3 and receiver 4 may together form a modem or portion thereof. Alternatively, hybrid circuit 1 may be a stand-alone device.

In general terms, hybrid circuit 1 is electrically connected to transmitter 3, receiver 4 and telecommunication line 2 to substantially isolate the input of receiver 4 from signals generated by transmitter 3. Hybrid circuit 1 isolates the input of receiver 4 in part by canceling common signals



appearing at the output of transmitter 3 and on  
telecommunications line 2. The remaining signal, a signal  
transmitted over telecommunications line 2 from a remote device,  
is applied to the input of receiver 4 for subsequent  
5 conditioning.

According to a preferred embodiment of the present  
invention shown in Figure 2, hybrid circuit 1 is adapted for use  
with a two-wire telecommunications line 2. In this case,  
transmitter 3 has a differential output generated by transmitter  
10 elements 3A and 3B, and receiver 4 has a differential input that  
feeds receiver elements 4A and 4B. Transmitter element 3A is  
coupled to receiver element 4A and to telecommunications line  
2A. Similarly, transmitter element 3B is coupled to receiver  
element 4B and to telecommunications line 2B. Transmitter  
15 elements 3A and 3B are each associated with an output resistor  
Rout.

In this first embodiment of the present invention, hybrid  
circuit 1 includes a pair of circuits. First circuit 5 is  
connected to a telecommunications line 2A, an output of  
20 transmitter element 3B and an input to receiver element 4A.  
First circuit 5 is a capacitive divider including a first  
capacitor 6 having a first terminal connected to  
telecommunications line 2A and a second terminal, a second

capacitor 7 having a first terminal connected to the output of transmitter element 3B and a second terminal that is connected to the second terminal of capacitor 6, and a pull-down device 8 connected between the input of receiver 4A and ground. The  
5 capacitance values of capacitors 6 and 7 are chosen so that common signals between the output of transmitter element 3B and signals appearing on telecommunications line 2A are scaled relative to each other so as to be substantial inversions of each other. Because the two scaled signals are added together  
10 at the input of receiver element 4A, the two scaled signals are substantially canceled thereat.

For example, in the event the output resistance  $R_{out}$  associated with transmitter elements 3A and 3B substantially matches the resistive load 10 of telecommunications line 2, the  
15 voltage level of the signal generated by transmitter element 3B is twice the voltage level of the related signal appearing at telecommunications line 2A. By assigning the capacitance value of C6 to be twice the capacitance value of capacitor C7, the output signal generated by transmitter element 3B is scaled by  
20 one third ( $1/3$ ) at the input of receiver 4A and the corresponding signal appearing on transmission line 2A is scaled by two thirds ( $2/3$ ) thereat. As can be seen, these signals cancel each other at the input of receiver element 4A. The

resulting signal appearing at the input of receiver element 4A is a portion of the differential signal transmitted to receiver 4 by a remote transmitter.

5 In the event information is communicated over telecommunications line 2 using a protocol in which the uplink frequency range does not completely overlap the downlink frequency range, such as the ADSL protocol, the capacitive divider of first circuit 5 is configured as a filter for filtering signal components at unwanted frequencies (uplink or  
10 downlink) from appearing at the input of receiver element 4A. For use in an ADSL modem or other similar device which transmits signals to another device on the uplink and receives transmitted signals on the downlink, first circuit 5 is configured as a high pass filter. As shown in Figure 2, pull-down device 8 is a  
15 resistor having a resistance value that, when combined with capacitors 6 and 7, substantially filters ADSL uplink signals transmitted by transmitter 3.

In a preferred embodiment of the present invention that is adapted for use with a two-wire telecommunications line 2,  
20 hybrid circuit 1 further includes a second circuit 12 which is electrically connected to telecommunications line 2B, the output of transmitter element 3A and the input of receiver element 4B. Second circuit 12 preferably mirrors first circuit 5 so as to

correspondingly scale the output of transmitter element 3A and the related signal appearing on telecommunications line 2B relative to each other. In this way, the scaled signals cancel each other at the input to receiver element 4B so that receiver  
5 element 4B only receives signals transmitted by a remote transmitting device.

Similar to first circuit 5, second circuit 12 is implemented as a capacitive divider in order to suitably scale the signals for cancellation. Second circuit 12 preferably  
10 includes capacitor 13 having a first terminal connected to telecommunications line 2B and a second terminal, and capacitor 14 having a first terminal connected to the output of transmitter element 3A and a second terminal connected to the second terminal of capacitor 13. The capacitance values of  
15 capacitors 13 and 14 are chosen based upon the ratio of the signal voltage generated by transmitter element 3A to the signal voltage appearing on telecommunications line 2B due to the signal generated by transmitter element 3A. The capacitance values for capacitors 13 and 14 are chosen so that the ratio of  
20 the capacitance value of capacitor 13 to the capacitance value of capacitor 14 is the ratio of the voltage swing of the signal appearing at the output of transmitter element 3A to the voltage swing of the corresponding signal appearing on

telecommunications line 2B. In this way, signals generated by transmitter 3A are substantially canceled at the input of receiver 4B.

5 In the event hybrid circuit 1 is associated with the communication of information using a protocol at which the frequency range of uplink signals does not completely overlap with the frequency range of corresponding downlink signals, the capacitive divider of second circuit 12 is configured as a filter. For a modem or other device utilizing the ADSL protocol  
10 for receiving downlink signals and transmitting uplink signals, second filter 12 is configured as a high pass filter to filter out uplink transmissions by transmitter element 3A. Resistor 15 of second circuit 12 is connected between the input of receiver element 4B and ground so as to cooperate with capacitors 13 and  
15 14 in forming a high pass filter.

Referring to Figure 3, there is shown hybrid circuit 31 according to another preferred embodiment of the present invention for use with a single ended or one-wire telecommunications line. Hybrid circuit 31 is coupled to  
20 telecommunications line 32, the single ended output of transmitter 33, and the single ended input of receiver 34. Hybrid circuit 31 includes a capacitive divider circuit 35 for suitably scaling the output signal generated by transmitter 33

and the corresponding signal appearing on telecommunications line 32 so that they cancel each other at the input of receiver 34.

Specifically, capacitive divider circuit 35 includes a  
5 capacitor 36 having a first terminal connected to telecommunications line 32 and a second terminal, and capacitor 37 having a first terminal coupled to the output of transmitter 33 and a second terminal connected to the second terminal of capacitor 36. The capacitance values of capacitors 36 and 37  
10 are chosen depending upon the ratio of the signal voltage generated by transmitter element 33 to the signal voltage appearing on telecommunications line 32 due to transmitter element 33. The capacitance values for capacitors 36 and 37 are chosen so that the ratio of the capacitance value of capacitor  
15 36 to the capacitance value of capacitor 37 is the ratio of the voltage swing of the signal appearing at the output of transmitter element 33 to voltage swing of the corresponding signal voltage appearing on telecommunications line 32. In this way, signals generated by transmitter 33 are substantially  
20 canceled at the input of receiver 34.

In the event hybrid circuit 31 is associated with the communication of information using a protocol at which the frequency range of uplink signals does not completely overlap

with the frequency range of corresponding downlink signals, the capacitive divider of capacitive divider circuit 35 is configured as a filter. For a modem or other device utilizing the ADSL protocol for receiving downlink signals and transmitting uplink signals, capacitive divider circuit 35 is configured as a high pass filter to filter out uplink transmissions. Resistor 38 of capacitive divider circuit 35 is connected between the input of receiver 34 and ground so as to cooperate with capacitors 36 and 37 in forming a high pass filter.

Because hybrid circuit 31 is associated with a single ended telecommunications line 32, in order for the signals scaled by hybrid circuit 31 to cancel at the input of receiver 34, hybrid circuit 31 further includes an amplifier circuit 39 having an input connected to the output of transmitter 33 and an output connected to the first terminal of capacitor 37. Amplifier circuit 39 is configured as an inverting amplifier. Amplifier circuit 39 inverts the voltage level of the output of transmitter 33 so as to produce an inverted voltage level which, following scaling by capacitive circuit 35, cancels the corresponding signal appearing on telecommunications line 32 that itself was scaled by capacitive circuit 35. In this way,

the contribution of the signal appearing at the input of receiver 34 due to transmitter 33 is substantially minimized.

A benefit of employing reactive elements in the divider of the present hybrid circuit to scale the signals for cancellation is that, unlike circuits utilizing resistive elements to scale  
5 signals, reactive elements do not generate an appreciable amount of thermal noise. As a result, the signal-to-noise ratio of the receive path of the present modem is not adversely affected by the present hybrid circuit. Further, because the capacitive  
10 divider circuit of the present hybrid circuit is configured as a filter, any thermal noise generated by the resistive element therein is suitably filtered.

It is understood that with respect to the ADSL protocol, the receiving path for a modem or other communications device  
15 requires at least a third order filter. The filter(s) in the receiving path are normally downstream of an amplifier stage. By implementing hybrid circuit 1 as a first order high pass filter which is positioned upstream of the amplifier stage (Figure 1), the filtering that is necessary downstream of the  
20 amplifier stage advantageously requires less complexity and can be implemented as an active filter implemented on an integrated circuit instead of an off-chip passive filter implemented using discrete L-C components.



It is understood that the present invention may be associated with a modem or other device including a transmitter for transmitting downlink information and a receiver for receiving uplink information at a different frequency range from the frequency range utilized by the transmitter, such as an uplink modem using the ADSL protocol. In this case, the hybrid circuit includes at least one resistive divider that is configured as a low pass filter. Figure 4 illustrates a hybrid circuit 41 for an uplink modem or other device that communicates differential signals over telecommunications line 42 using ADSL. The primary difference between hybrid circuit 41 of Figure 4 and hybrid circuit 1 of Figure 2 is that each of first circuit 43 and second circuit 44 of hybrid circuit 41 is a resistive divider that is configured as a low pass filter via connection with a capacitor. First and second circuits being each configured as low pass filters suitably filters the higher frequency downlink transmissions by transmitter elements 45A and 45B.

Relatedly, Figure 5 illustrates a hybrid circuit 51 for an uplink modem or other device that communicates single ended signals over telecommunications line 52 using ADSL. The primary difference between hybrid circuit 51 of Figure 5 and hybrid circuit 31 of Figure 3 is that the scaling circuit 53 is a

resistive voltage divider that is configured as a low pass filter via connection with a capacitor. In this way, circuit 53 suitably filters the higher frequency downlink transmissions by transmitter element so that only uplink information transmitted  
5 by a remote device is received at the input to receiver 55.

It is understood that a higher order filter, either passive or active and either low-pass or high-pass, can be used instead of the first order filters mentioned above with respect to the preferred embodiments of the present invention. In this case,  
10 either the first capacitor or resistor of the higher order filter will be split to form a voltage divider.

It is also understood that additional wiring in the transmission line transformer can be used instead of an amplifier, or the counterphase signal tapped from the differential transmission line driver circuits (transmitter  
15 elements) to generate a counterphase voltage for subsequent signal cancellation in the hybrid circuit described above.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to  
20 be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

**What is claimed is:**

1           1. A device for transmitting and receiving signals over a  
2     communications line, comprising:  
3           a transmitter circuit having an output coupled to the  
4     communications line;  
5           a receiver circuit having an input coupled to the  
6     communications line; and  
7           a hybrid circuit connected to the transmitter output, the  
8     receiver input and the communications line, for filtering  
9     signals at frequencies that fall outside of a predetermined  
10    frequency range, the hybrid circuit being configured as a  
11    voltage divider formed from reactive elements for substantially  
12    canceling signals transmitted by the transmitter circuit from  
13    appearing at the receiver input.

1           2. The device of claim 1, wherein:  
2     the hybrid circuit comprises a first order filter.

1           3. The device of claim 1, wherein:  
2     the hybrid circuit comprises a high pass filter.

1           4. The device of claim 1, wherein:  
2           the hybrid circuit is configured as a capacitive divider  
3           for scaling the signals at the transmitter output for  
4           cancellation with related signals appearing on the  
5           communications line.

1           5. The device of claim 4, wherein the hybrid circuit  
2           comprises:  
3           a first capacitor having a first terminal connected to the  
4           communications line and a second terminal;  
5           a second capacitor having a first terminal connected to the  
6           transmitter output and a second terminal connected to the second  
7           terminal of the first capacitor; and  
8           a resistor having a first terminal connected to the second  
9           terminal of the first capacitor and a second terminal connected  
10          to a reference voltage.

1           6. The device of claim 5, wherein:  
2           the ratio between the capacitance of the first capacitor to  
3           the capacitance of the second capacitor is substantially the  
4           same as the ratio between the voltage level at the transmitter  
5           output to the voltage level of a related signal appearing on the  
6           communications line.

1           7. The device of claim 1, wherein:  
2           the communications line comprises a differential pair of  
3           communications lines;  
4           the transmitter output is a differential output;  
5           the receiver input is a differential input; and  
6           the hybrid circuit comprises a first filter circuit having  
7           a first terminal connected to a first line of the differential  
8           pair of communications lines, a second terminal connected to a  
9           first line of the differential output of the transmitter and a  
10          third terminal connected to a first line of the differential  
11          input of the receiver, the first filter circuit being configured  
12          as a voltage divider formed from reactive elements for  
13          substantially canceling signals transmitted by the transmitter  
14          and appearing on the first terminal of the differential output  
15          thereof from appearing at the first line of the differential  
16          input of the receiver.

1           8. The device of claim 7, wherein:

2           the hybrid circuit further comprises a second filter  
3           circuit having a first terminal connected to a second line of  
4           the differential pair of communications lines, a second terminal  
5           connected to a second line of the differential output of the  
6           transmitter and a third terminal connected to a second line of  
7           the differential input of the receiver, the second filter  
8           circuit being configured as a voltage divider formed from  
9           reactive elements for substantially canceling signals  
10          transmitted by the transmitter and appearing on the second  
11          terminal of the differential output thereof from appearing at  
12          the second line of the differential input of the receiver.

1           9. The device of claim 8, wherein:

2           the second filter circuit forms a capacitive divider.

1           10. The device of claim 8, wherein:

2           the second filter circuit comprises a pair of series  
3           connected capacitors connected between the second line of the  
4           differential pair of communications lines and the second line of  
5           the differential output of the transmitter, and a resistor  
6           having a first terminal connected to each of the capacitors and  
7           a second terminal connected to a reference voltage.

1           11. The device of claim 8, wherein:  
2           the second filter circuit comprises a first order, high  
3           pass filter.

1           12. The device of claim 8, wherein:  
2           the first filter circuit and the second filter circuit each  
3           comprise a first order high pass filter.

1           13. The device of claim 7, wherein:  
2           the first filter circuit forms a capacitive divider.

1           14. The device of claim 7, wherein:  
2           the first filter circuit comprises a pair of series  
3           connected capacitors connected between the first line of the  
4           differential pair of communications lines and the second line of  
5           the differential output of the transmitter, and a resistor  
6           having a first terminal connected to each of the capacitors and  
7           a second terminal connected to a reference voltage.

1           15. The device of claim 7, wherein:  
2           the hybrid circuit further comprises an amplifier circuit  
3           configured as an inverting amplifier that is connected between  
4           the transmitter output and the first filter circuit, the  
5           amplifier circuit and the first filter circuit generating a  
6           first scaled output voltage signal and a second scaled voltage  
7           signal which cancel each other at the receiver input.



1           16. A hybrid circuit associated with an end of a  
2     telecommunications line to which a transmitter and a receiver  
3     are connected, comprising:

4           a first circuit having a first terminal coupled to an  
5     output of the transmitter, a second terminal coupled to an input  
6     of the receiver and a third terminal coupled to the  
7     telecommunications line, for canceling signals transmitted by  
8     the transmitter from appearing at the receiver input and  
9     filtering signals at predetermined frequencies on the  
10    telecommunications line from appearing at the receiver input so  
11    that the receiver is substantially isolated from the  
12    transmitter, the first circuit forming a voltage divider of  
13    reactive elements that is configured as a filter.

1           17. The hybrid circuit of claim 16, wherein:  
2     the first circuit comprises a high pass filter.

1           18. The hybrid circuit of claim 16, wherein:  
2     the first circuit capacitively scales signals appearing at  
3     the output of the transmitter and on the telecommunications line  
4     so as to substantially cancel common signals therebetween.

1           19. The hybrid circuit of claim 18, wherein:  
2           the first circuit is configured as a high pass filter.

1           20. The hybrid circuit of claim 18, wherein the first  
2           circuit comprises:

3           a first capacitor having a first terminal connected to the  
4           telecommunications line and a second terminal;

5           a second capacitor having a first terminal connected to the  
6           transmitter output and a second terminal connected to the second  
7           terminal of the first capacitor; and

8           a resistor connected between to the second terminal of the  
9           first capacitor and a reference voltage.

1           21. The hybrid circuit of claim 20, wherein:

2           the ratio between the capacitance value of the first  
3           capacitor to the capacitance value of the second capacitor is  
4           substantially the same as the voltage swing of signals at the  
5           transmitter output to the voltage swing of related signals  
6           appearing on the telecommunications line.

1           22. The hybrid circuit of claim 17, further comprising:  
2           a second circuit configured as an inverting amplifier, the  
3           second circuit connected between the transmitter output and an  
4           input of the first circuit.

1           23. The hybrid circuit of claim 16, wherein:  
2           the transmitter output is a differential output;  
3           the receiver input is a differential input;  
4           the telecommunications line is a two-wire line;  
5           the first terminal of the first circuit is connected to a  
6           first output line of the transmitter output, the second terminal  
7           of the first circuit is connected to a first input line of the  
8           receiver, and the third terminal of the first circuit is  
9           connected to a first line of the telecommunications line; and  
10          the hybrid circuit further comprises a second circuit  
11          having a first terminal connected to a second output line of the  
12          transmitter output, a second terminal connected to a second  
13          input line of the receiver, and a third terminal connected to a  
14          second line of the telecommunications line, for canceling  
15          signals relating to signals generated by the transmitter and  
16          appearing at the second input line of the receiver, and for  
17          filtering signals on the second telecommunications line at  
18          predetermined frequencies from appearing at the second input

19 line of the receiver, the second circuit forming a voltage  
20 divider of reactive elements that is configured as a filter.

1 24. The hybrid circuit of claim 23, wherein:  
2 the second circuit capacitively scales signals appearing at  
3 the second output line of the transmitter and signals appearing  
4 on the second telecommunications line so that common signals  
5 therebetween cancel at the second input of the receiver.

1           25. A hybrid circuit associated with an end of a  
2 telecommunications line to which a transmitter and a receiver  
3 are connected, comprising:

4           a first filter circuit connected to an output of the  
5 transmitter, the telecommunications line and an input of the  
6 receiver, for filtering signals at predetermined frequencies  
7 appearing on the transmitter output and the telecommunications  
8 line, scaling signals appearing on the transmitter output, and  
9 canceling the scaled signals at the receiver input with related  
10 signals appearing on the telecommunications line.

1           26. The hybrid circuit of claim 25, wherein:

2           the first filter circuit includes a first reactive  
3 component connected between the telecommunications line and the  
4 receiver input, a first electrical component connected between  
5 the transmitter output and the receiver input, and a second  
6 electrical component connected between the receiver input and a  
7 reference voltage.

1           27. The hybrid circuit of claim 25, wherein:

2           the first filter circuit is configured as a capacitive  
3 divider.

1        28. The hybrid circuit of claim 27, wherein:  
2        the first filter circuit forms a high pass filter.

1        29. The hybrid circuit of claim 27, wherein:  
2        the first filter circuit includes a first capacitor  
3        connected to the transmitter output, a second capacitor  
4        connected to the telecommunications line and a resistor  
5        connected to the first and second capacitors.

1        30. The hybrid circuit of claim 29, wherein:  
2        the ratio of the capacitance value of the first capacitor  
3        to the capacitance value of the second capacitor is  
4        substantially the same as the voltage swing of the signals  
5        appearing on the transmitter output to the voltage swing of the  
6        related signals appearing on the telecommunications line.

1        31. The hybrid circuit of claim 25, wherein:  
2        the first filter circuit forms a low pass filter.

**ABSTRACT OF THE DISCLOSURE**

A hybrid circuit is disclosed for effectively communicating information over a telecommunications line to which a transmitter and receiver are connected. The hybrid circuit is configured as a filter for filtering at the receiver input signals at predetermined frequencies appearing on the transmitter output and the telecommunications line. The filter circuit additionally forms a capacitive divider for scaling signals appearing at the transmitter output and canceling the scaled signals at the receiver input with related signals appearing on the telecommunications line. In one embodiment of the present invention for communicating using the ADSL protocol, the filter circuit is a first order high pass filter.

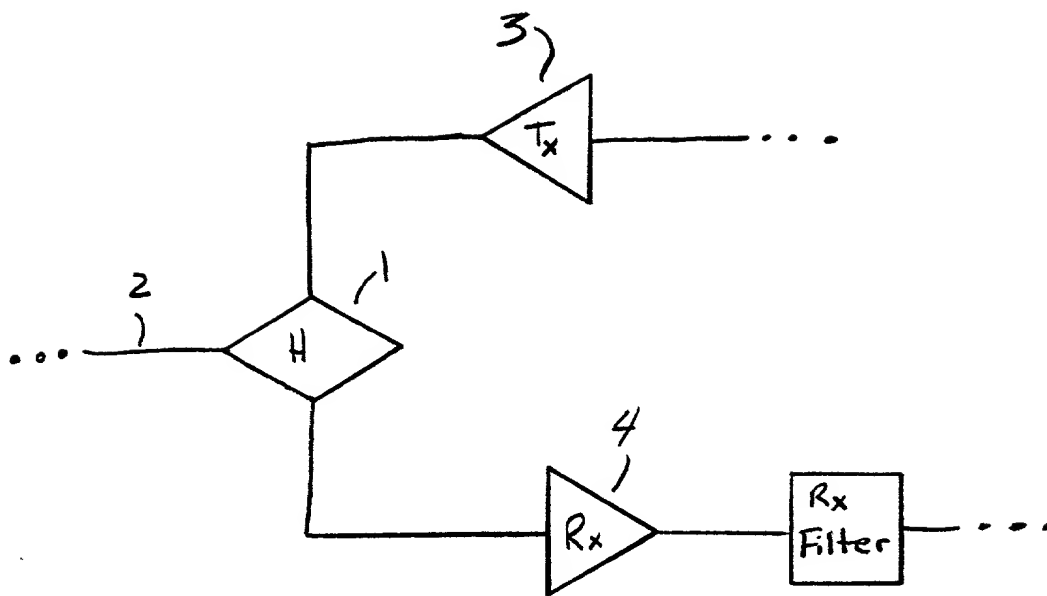


FIGURE 1

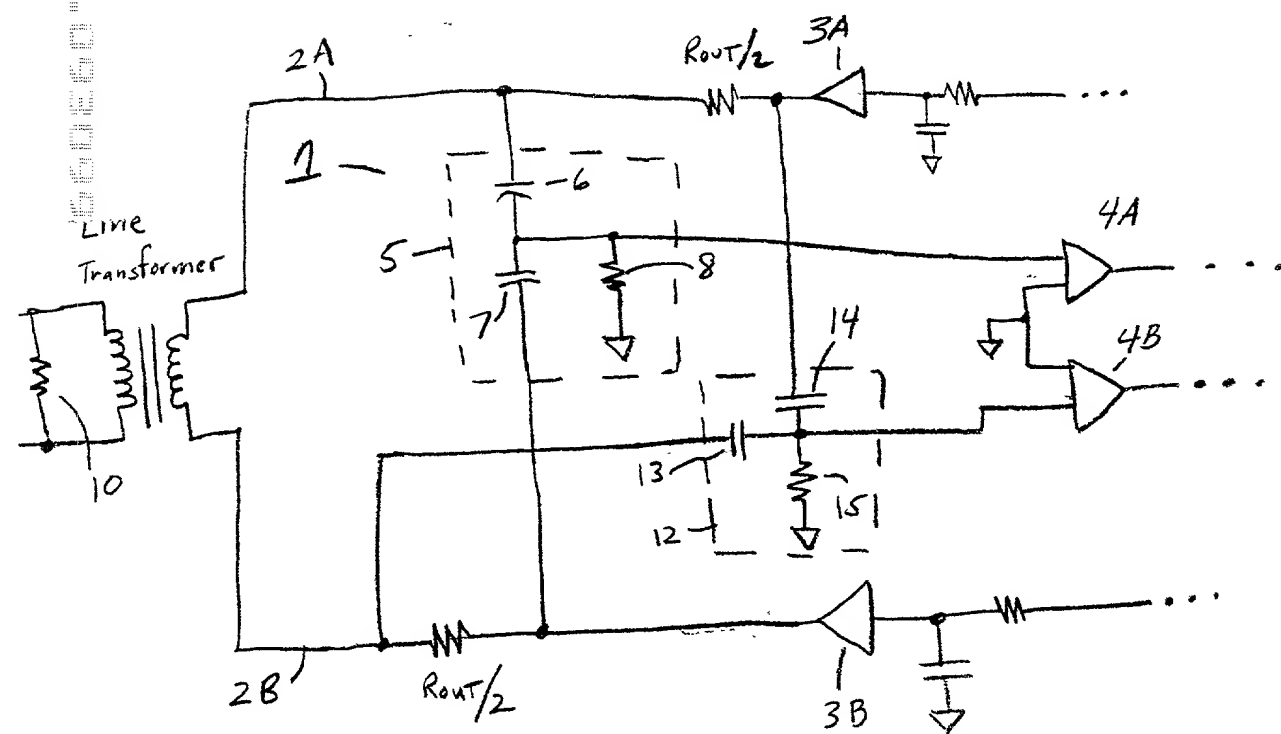


FIGURE 2



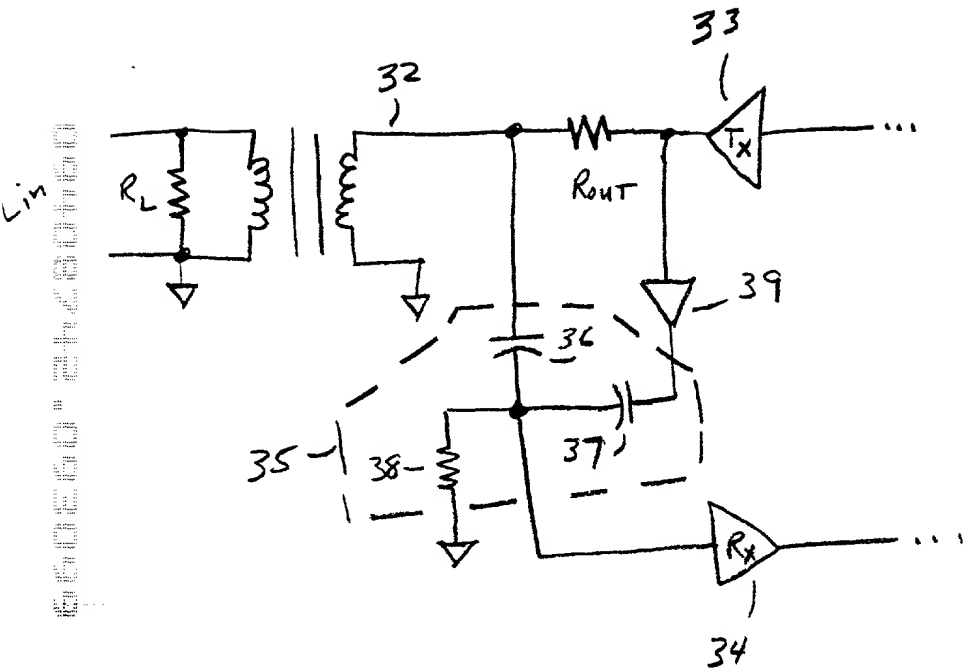


FIGURE 3

66060 24280460

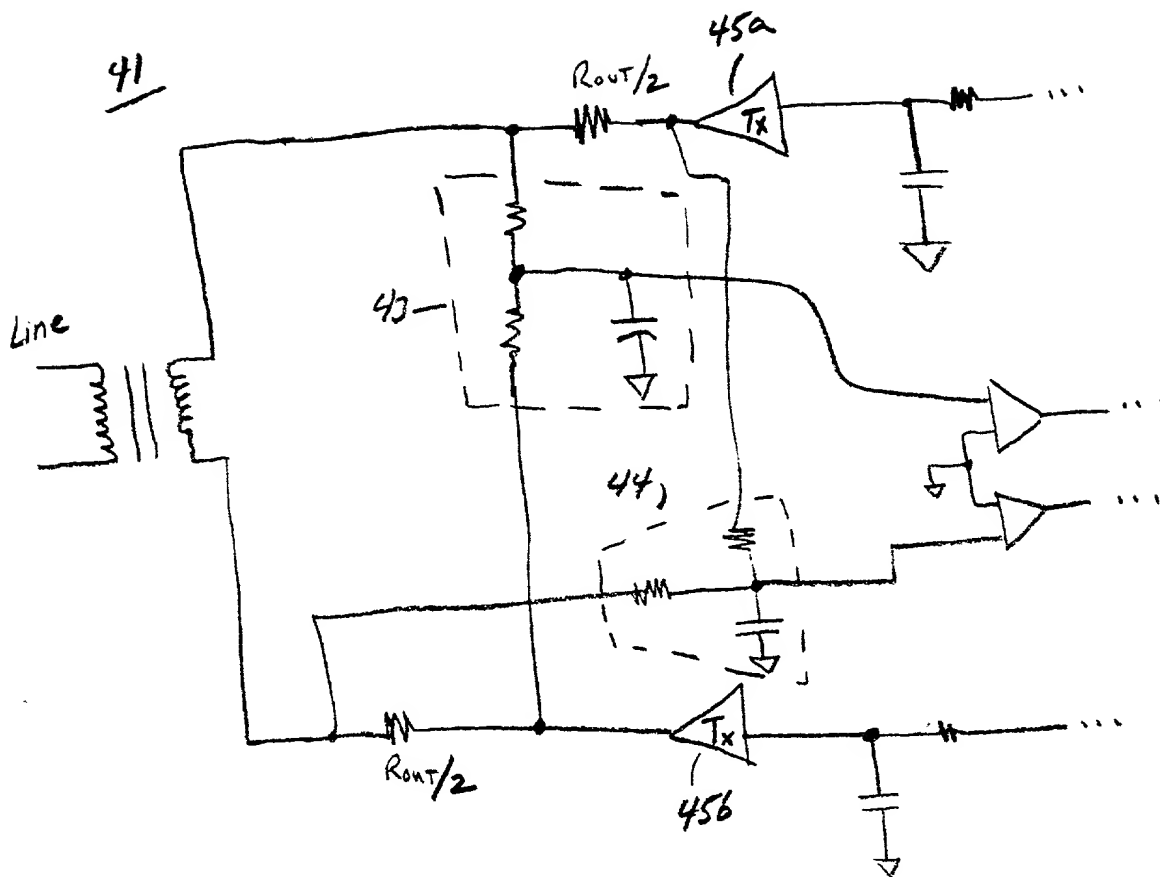


FIGURE 4

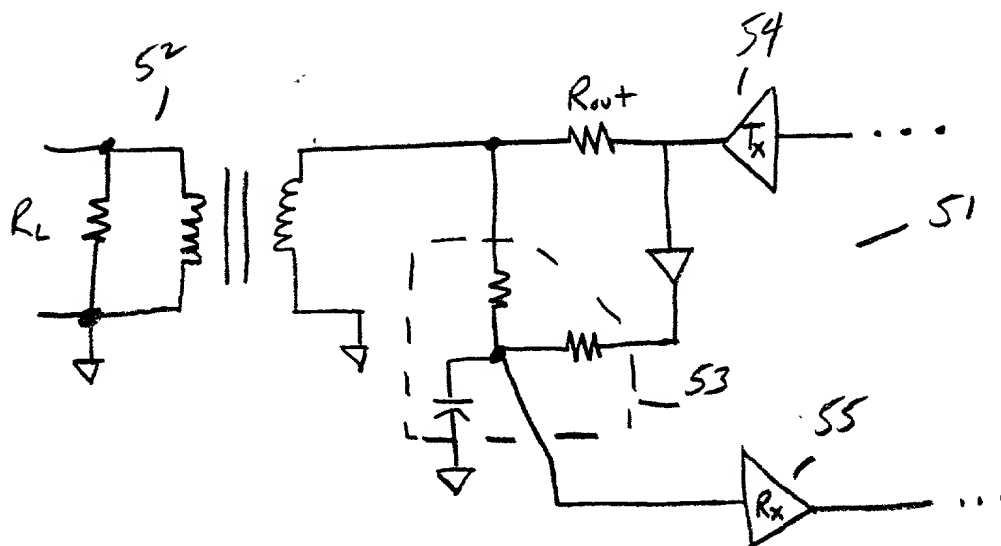


FIGURE 5

**COMBINED DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and

I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **TELEPHONE LINE INTERFACE CIRCUIT AND METHOD**

the specification of which:

X is attached hereto.

\_\_\_\_\_ was filed on \_\_\_\_\_ as Application Serial No. \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to the patentability of this application as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of any application on which priority is claimed:

Country	Number	Date Filed	Priority Claimed
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability of the application as defined in 37 CFR § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.

Filing Date


Status (patented, pending)

I hereby appoint the following attorneys and/or agents to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: LISA K. JORGENSEN, Reg. No. 34,845, ROBERT D. McCUTCHEON, Reg. No. 38,717, JEFF MOY, Reg. No. 39,307 and THEODORE E. GALANTHAY, Reg. No. 24,122, of STMicroelectronics, Inc. of 1310 Electronics Drive, Carrollton, Texas 75006-5039; and ANDRE M. SZUWALSKI, Reg. No. 35,701, WILLIAM TUCKER, Reg. No. 41,356, and WILLIAM F. ESSER, Reg. No. 38,053 of the firm of JENKENS & GILCHRIST, 3200 Fountain Place, 1445 Ross Avenue, Dallas, Texas 75202-2799; and

Address all telephone calls and correspondence to:

Lisa K. Jorgenson, Esq.  
STMicroelectronics, Inc.  
1310 Electronics Drive, MS 2346  
Carrollton, Texas 75006  
972/466-6000

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1	Albert Vahdjian		29/9/99
	Inventor's Signature		Date
	701-25 Woodridge Cres Nepean Ontario, Canada Residence		Australian Citizenship
701-25 Woodridge Cres Nepean Ontario, Canada K2B 7T4 Post Office Address			

Dallas 2 623a29 v 1, 289-0,000-5